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SEEDING RECOMMENDATIONS FOR DISTURBED MOUNTAIN SLOPES IN NORTH CENTRAL WASHINGTON

by

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ABSTRACT

Many native and introduced plant species were tested for their ability to become established on highly disturbed soils on upper elevation slopes in north central Washington. Latar orchardgrass, Drummond timothy, perennial ryegrass, Manchar smooth brome, and tall fescue proved to be the best adapted species. A starter fertilizer treatment is essential for successful plantings.

KEYWORDS: Soil management (forest), forest damage-) fire.

A series of lightning fires in July and August 1970 resulted in major forest fires covering 138,000 acres (55 850 ha) on the Entiat and Chelan Districts of the Wenatchee National Forest and Twisp District of the Okanogan National Forest. During the fires, more than 135 miles (219 km) of major fireline up to 300 feet (90 m) in width were constructed with tractors. The majority of the firelines were placed on ridgetops ranging from 2,950 to 6,900 feet (900 to 2 100 m) elevation. Forest cover along the firelines ranged from ponderosa pine (*Pinus ponderosa* Laws.)[1/] at lower elevations to subalpine fir-whitebark pine (*Abies lasiocarpa* (Hook.) Nutt.-*Pinus albicaulis* Engelm.) at the upper elevations.

In most areas, major firelines were constructed with tractors during the fires. After the fires, tractors were used periodically through the summer of 1972 in a fuels management program to burn all construction residue. Surface condition after the tractor operation ranged from minimum disturbance, with little impact on the understory vegetation, to extreme disturbance where all vegetation was completely removed.

In the rehabilitation project after the fire, 926 acres (375 ha) of firelines were seeded and fertilized for erosion control.[2/] Seeding rates varied from 6 to 9 pounds per acre (6.7 to 10.1 kg/ha) of a mixture composed of orchardgrass (*Dactylis glomerata* L.), hard fescue (*Festuca ovina* var. *duriuscula* L.), timothy (*Phleum pratense* L.), and sweet clover (*Melilotus officinalis* (L.) Laws.). Fertilizer in the form of urea was applied at a rate of 70 pounds per acre (78 kg/ha). Both seed and fertilizer were broadcast by helicopter in late fall 1970. In many areas, particularly at higher elevations and on severely disturbed pumice soils, there was little evidence of seedling emergence and survival in September 1971.

STUDY

In 1971, a study was initiated to test the relative ability of the various plant species to become established under conditions present on these firelines; certified seed[3/] of 40 plant species were seeded on plots in the firelines. Fertilizer was applied as a secondary treatment. Four study locations, all on sites severely disturbed by tractor operation, were:

1. Dinkelman Ridge, elevation 4,100 feet (1 250 m). Soils are derived from Swauk sandstone parent material and are generally loamy sands. Local vegetation is mixed conifer, including Douglas-fir (*Pseudotsuga menziesii* (Mirb.) Franco), and

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[1/] Scientific names of trees are according to Elbert L. Little, Jr., Checklist of native and naturalized trees of the United States (including Alaska). USDA Forest Service, Agriculture Handbook No. 41, 472 p., 1953.

[2/] R. F. Perkins, R. A. Woodward, and T. P. Ryan. Operational report of rehabilitation of the north central Washington fires. USDA Forest Service, Wenatchee National Forest Release, 33 p. 1971.

[3/] Most seed was provided by Mr. John L. Schwendiman, Plant Material Specialist, Soil Conservation Service, Pullman, Washington.

ponderosa pine with an understory of pinegrass (*Calamagrostis rubescens* Buckl.).[4/]

2. Sugarloaf Corral, elevation 5,050 feet (1 540 m). Soils are derived from Swauk sandstone. Local vegetation is predominantly lodgepole pine (*Pinus contorta* Dougl.), subalpine fir, and grouse whortleberry (*Vaccinium scoparium* Leiberg).

3. Handy Springs, elevation 6,560 feet (2 000 m). Soils are predominantly volcanic ash with some pumice. Vegetation is subalpine fir, whitebark pine, and various sedges (*Carex* spp.).

4. Silver Creek, elevation 4,500 feet (1 370 m). Soils are "popcorn" pumice with a thin layer of volcanic ash cover in some locations. Vegetation is lodgepole pine-grouse whortleberry.

Varieties and seeding rates used at each location are shown in table 1. An attempt was made to apply 100 seeds per square foot (328 seeds/m^2) for small seeds and 40 seeds per square foot (130 seeds/m^2) for large seed species. Fertilization was at the rate of 300 pounds per acre (336 kg/ha) of ammonium phosphate sulphate (16-20-0-15). Secondary plots without fertilization were also used for some varieties. Seed and fertilizer were applied by the broadcast method in late September 1971 on experimental plots 15- by 20-feet (4.6- by 6.1-m) in size. Legumes were not inoculated. Experimental plots were not replicated at each location.

Since a mixture of plant species was used in the 1970 postfire rehabilitation planting on the firelines, a test of competition among species appeared desirable, so we mixed several varieties of annuals and perennials on experimental plots. Composition and planting rate for each species used within several mixes are shown in table 2.

Ground coverage of the planted species was measured by the point method with 20 pins (see footnote 4) in August 1972 and again in August 1973.

RESULTS AND DISCUSSION

Table 1 presents a summary of seeding rates and percent plant cover for all experimental plots in 1972 and 1973. After 2 years of growth, four perennials appear to have been satisfactorily established at all planting locations. These were orchardgrass, timothy, perennial ryegrass,[5/] and smooth brome. These species germinated and became satisfactorily established (foliar cover greater than 20 percent of the soil surface) whether planted individually or in a mixture in the 2,950 to 6,890-foot (900- to 2 100-m) elevation zone. Tall fescue also showed an excellent foliar cover (38-to 68-percent) in the first year but appeared to freeze out in 1973 at high elevation Handy Springs.

[4/] Dorothy Brown. Methods of surveying and measuring vegetation. Commonwealth Bureau of Pastures and Field Crops, Bull. 42, 223 p. Farnham Royal, Bucks, England. 1954.

[5/] Scientific names not shown in text are listed in tables 1 and 2.

Table 1.--*Foliar cover on experimental plots for selected grasses, legumes, and shrubs, 1 and 2 years after planting*[1/]

Common name	Scientific name[2/]	Variety	Seeding rate	Oinkelman Ridge		Sugarloaf Corral		Handy Springs		Silver Creek	
				1972	1973	1972	1973	1972	1973	1972	1973
			kg/ha (lb/acre)	- - - - - - - - - - - - - - - *Percent* - - - - - - - - - - - - - - -							
Perennial grasses:											
Orchardgrass	*Dactylis glomerata*	Latar	10.8 (9.6)	50	42	70	72	37	32	30	40
Tall fescue	*Festuca arundinacea*	Alta	81.7 (72.9)	54	67	68	53	38	1	40	28
Hard fescue	*Festuca ovina* var. *duriuscula*	Ourar	10.4 (9.3)	42	25	16	40	15	0	1	20
Sheep fescue	*Festuca ovina* var. *sulcata*		5.4 (4.8)	14	33	0	5	3	0	0	3
Smooth brome	*Bromus inermis*	Manchar	30.2 (26.9)	[3/]2(8)	40(3)	27(0)	33(10)	[4/]2(0)	0(0)	15(0)	23(0)
Beardless wheatgrass	*Agropyron inerme*	Whitmar	48.4 (43.2)	34	25	13	18	0	0	0	1
Intermediate wheatgrass	*Agropyron intermedium*	Amur	75.3 (67.2)	2	15	42	45	25	7	0	17
Intermediate wheatgrass	*Agropyron intermedium*	Greenar	58.4 (52.1)	52	42	57	28	18	0	28	17
Pubescent wheatgrass	*Agropyron trichophorum*	Topar	64.1 (57.2)	5	7	43	15	20	0	2	3
Siberian wheatgrass	*Agropyron sibiricum*		28.7 (25.6)	18	0	15	0	0	0	0	0
Slender wheatgrass	*Agropyron trachycaulum*	Primar	45.2 (40.3)	20	38	0	13	17	0	32	27
Streambank wheatgrass	*Agropyron riparium*	Sodar	40.9 (36.5)	0	0	2	2	0	0	0	30
Tall wheatgrass	*Agropyron elongatum*	Alkar	81.7 (72.9)	66	87	29	2	0	0	3	13
Thickspike wheatgrass	*Agropyron dasystachyum*		33.3 (29.7)	8	8	12	7	0	0	28	25
Big bluegrass	*Poa ampla*	Sherman	64.6 (57.6)	42	83	43	2	0	0	20	40
Canada bluegrass	*Poa compressa*		2.4 (2.1)	0	0	15	28	18	47	4	30
Indian ricegrass	*Oryzopsis hymenoides*		30.8 (27.5)	0	0	0	0	0	0	0	0
Perennial ryegrass	*Lolium perenne*		27.9 (24.9)	13	27	85	80	42	48	40	38
Timothy	*Phleum pratense*	Orummond	4.3 (3.8)	24	32	62	53	28	42	38	15
Blue wildrye	*Elymus glaucus*		41.9 (37.4)	0	0	0	0	0	0	0	0
Russian wildrye	*Elymus junceus*		43.1 (38.4)	0	0	0	0	0	0	0	0
Black medic	*Medico sativa*		27.6 (24.6)	0	0	--	--	--	--	--	--
Side oats grama	*Bouteloua curtipendula*		30.5 (27.2)	0	0	--	--	--	--	--	--
Lodorm green needlegrass	*Stipa viridula*		21.5 (19.2)	0	0	0	0	0	0	0	0
Common green needlegrass	*Stipa viridula*		33.0 (29.4)	0	0	--	--	--	--	--	--
Annual grasses:											
Common ryegrass	*Lolium* sp.		26.6 (23.7)	2(0)	0(0)	22(0)	30(1)	0(0)	0(0)	(4/)	--
Wheat	*Agropyron triticeum*		172.8 (154.1)	20(3)	0(0)	13(10)	0(0)	0(2)	0(0)	(4/)	--
Cereal rye	*Secale cereale*		109.8 (97.9)	32(5)	0(0)	30(10)	0(0)	17(5)	0(0)	(4/)	--
Legumes:											
Cicer milkvetch	*Astragalus cicer*	Cicar	46.3 (41.3)	0	0	0	0	0	0	0	0
Red clover	*Trifolium pratense*	Mammoth	25.8 (23.0)	0	0	0	0	2	0	0	0
Yellow sweet clover	*Melilotus officinalis*		29.0 (25.9)	0	0	1	0	0	0	0	0
Birdsfoot trefoil	*Lotus corniculatus*		12.6 (11.2)	0	0	0	0	0	0	0	0
Bramble vetch	*Vicia tenuifolia*		22.2 (19.8)	0	0	0	0	0	0	0	0
Common sainfoin	*Onobrychis viciaefolia*	Onar	98.6 (87.9)	3(0)	0(0)	3(1)	0(0)	5(9)	0(0)	(4/)	--
Shrubs:											
Antelope bitterbrush	*Purshia tridentata*		265.4 (236.7)	0	0	--	--	--	--	--	--

[1/] All plots were fertilized with ammonium phosphate sulfate (16-20-0-15) at the rate of 336 kg/ha.

[2/] Scientific names are according to Harlan P. Kelsey and William A. Oayton, Standardized plant names. 675 p. J. Horace McFarland Company, Harrisburg, Pa., 1942.

[3/] Percent plant cover in another experimental plot of same plant variety but not fertilized is in parentheses.

[4/] Experimental plot disturbed by tractor operation.

Table 2.--*Fertilized and unfertilized foliar cover on experimental plots for mixed plant species, 1 and 2 years after planting*

Common name	Scientific name[1/]	Variety	Seeding rate	Oinkelman Ridge				Sugarloaf Corral				Mandy Springs			
				1972		1973		1972		1973		1972		1973	
				Fert.	No fert.	Fert.	No fert.	Fert.	No fert.	Fert.	No fert.	Fert.	No fert.	Fert.	No fert.
			kg/ha (lb/acre)	*Percent*											
Mix 1:															
Smooth brome	*Bromus inermis*	Manchar	11.2 (10.0)	8	0	10	0	0	0	5	0	0	0	0	8
Timothy	*Phleum pratense*	Orummond	1.1 (1.0)	23	3	28	13	8	0	42	0	7	5	45	30
Mard fescue	*Festuca ovina* var. *duriuscula*	Ourar	2.6 (2.3)	11	0	10	3	0	0	0	0	0	0	0	0
Crested wheat-grass	*Agropyron desertorum*	Nordan	7.3 (6.5)	0	0	8	0	0	0	0	0	0	0	0	2
	Total cover (above species)			42	3	56	16	8	0	47	0	7	5	45	40
Mix 2:															
Annual wheat	*Agropyron triticeum*		27.2 (24.3)	0	0	0	0	0	0	0	0	0	0	0	0
Common sainfoin	*Onobrychis viciaefolia*	Onar	19.7 (17.6)	3	0	0	0	0	0	0	0	0	0	0	0
Cereal rye	*Secale cereale*		4.4 (3.9)	7	8	0	0	0	0	0	0	15	0	0	0
Common ryegrass	*Lolium* sp.		4.7 (4.2)	0	0	0	0	0	0	5	0	3	0	0	0
Mustard	*Brassica* sp.	Giant	5.4 (4.8)	0	0	0	0	3	0	0	0	0	0	0	0
	Total cover (above species)			10	8	0	0	3	0	5	0	18	0	0	0
Mix 3:															
Annual wheat	*Agropyron triticeum*		23.0 (20.5)	8	3	0	0	2	0	0	0	2	0	0	0
Common sainfoin	*Onobrychis viciaefolia*	Onar	14.4 (12.8)	0	0	0	0	2	0	0	0	0	0	0	0
Cereal rye	*Secale cereale*		16.5 (14.7)	3	2	0	0	10	0	0	0	10	7	0	0
Smooth brome	*Bromus inermis*	Manchar	7.0 (6.2)	2	18	3	7	0	0	0	0	0	0	2	0
Timothy	*Phleum pratense*	Orummond	0.7 (0.6)	2	8	0	3	3	0	40	0	2	0	42	10
Hard fescue	*Festuca ovina* var. *duriuscula*	Ourar	1.5 (1.3)	2	0	0	3	2	0	2	0	0	0	0	0
Crested wheat-grass	*Agropyron desertorum*	Nordan	4.4 (3.9)	0	0	3	0	0	0	0	0	0	0	0	0
	Total cover (above species)			17	31	6	13	19	0	42	0	14	7	44	10
Mix 4:															
Mustard	*Brassica* sp.	Florida broadleaf	12.0 (10.7)	(2/)	--	0	0	3	0	0	0	3	0	0	0
Mustard	*Brassica* sp.	Giant curl	12.0 (10.7)	--	--	0	0	8	0	0	0	0	0	0	0
	Total cover (above species)			--	--	0	0	11	0	0	0	3	0	0	0
Mix 5:															
Garden pea	*Pisum sativum*	Austrian	223.0 (198.9)	3	7	0	0	7	0	7	0	12	8	0	0
Rape	*Brassica* sp.		32.3 (28.8)	8	7	0	0	5	0	0	0	10	2	0	0
	Total cover (above species)			11	14	0	0	12	0	7	0	22	10	0	0

1/ Scientific names are according to Marlan P. Kelsey and William A. Dayton, Standardized plant names. 675 p. J. Morace McFarland Company, Harrisburg, Pa., 1942.

2/ No species differentiation made.

The level of success with most species decreased with increasing elevation. Site preparation, need for fertilization, and correct time of planting must be more closely evaluated at higher elevations. Smooth brome did not establish satisfactorily at Handy Springs, primarily because the experimental site was disturbed by tractor operations after planting. We do not believe animal use had appreciable influence on success or failure of any particular species at any planting location.

Cereal rye was the only annual satisfactorily established on all fireline locations, but its primary value does not appear to be in the form of extensive live plant cover for the soil surface during the plant growth period. During the first growing season, it produces considerable dry matter which provides immediate protection for the soil surface. In subsequent years, this organic material may improve soil microclimate, particularly on harsh sites, resulting in a more acceptable site condition for the establishment of other plant species including natives such as sedges. The cereal rye experiment and plots of several other species were lost by disturbance from tractor operation at the Silver Creek location.

On the remaining plots, 11 species became established only within restricted elevations and soil types. Species and areas on which their use is not recommended are:

tall fescue	above 6,000-foot (1 830-m) elevation
hard fescue	above 6,000-foot (1 830-m) elevation
sheep fescue	above 5,000-foot (1 525-m) elevation and on coarse pumice soils
big bluegrass	above 6,000-foot (1 830-m) elevation
Canada bluegrass	below 4,500-foot (1 370-m) elevation
beardless wheatgrass	above 5,000-foot (1 525-m) elevation and on coarse pumice soils
intermediate wheatgrass (Amur)	on coarse pumice soils
intermediate wheatgrass (Greenar)	on coarse pumice soils
slender wheatgrass	above 4,500-foot (1 370-m) elevation
tall wheatgrass	above 5,500-foot (1 675-m) elevation and on coarse pumice soils
thickspike wheatgrass	above 4,500-foot (1 370-m) elevation

The inability of many species to become established at higher elevations appears to result from their susceptibility to damage from frost heaving, cold air and soil temperatures, short growing season, and high solar radiation levels. Although some of the tested plant species do not appear satisfactory for high elevations in north central Washington, they may be adaptable to similar elevations in other locations. Disturbed pumice soils found on the firelines are very coarse textured. Therefore, seed makes poor contact with the soil, resulting in poor nutrient and moisture availability and making establishment difficult for many plant species.

Many plant species appear unacceptable for general fireline use in the 2,950- to 6,900-foot (900- to 2 100-m) elevation zone of north central Washington. Species showing no evidence of emergence on the experimental plots were:

Indian ricegrass	green needlegrass
blue wildrye	Lodorm green needlegrass
Russian wildrye	black medic
Cicer milkvetch	side oats grama
birdsfoot trefoil	bitterbrush
bramble vetch	

Only a few plants emerged on the experimental plots seeded to sweet clover and red clover. Again we must point out that the legumes were not inoculated which could have had an important effect on their ability to become established.

Species showing establishment at one or more locations but which are not recommended for general use on firelines in north central Washington because of inadequate cover and vigor are:

pubescent wheatgrass	wheat
Siberian wheatgrass	mustard
streambank wheatgrass	pea
sainfoin	rape
common ryegrass	

Sainfoin appeared to be the only legume that might be successful on firelines. However, since legumes were not inoculated, this study probably does not provide a true indication of their suitability for seeding disturbed areas such as firelines. Because of their nitrogen-fixing capability, legumes are desirable in highly disturbed areas with low nitrogen capital. Also, their large seeds are excellent food for small animals and birds. It thus appears there should be more extensive research on the use of legumes, and in particular of sainfoin, for seeding areas as severely disturbed as firelines.

When several species were seeded as a mixture, growth of all species was less satisfactory than when seeded singly (table 2). With the exception of cereal rye, perennials predominantly provided the greatest ground cover in the mixed species plots. As in the individual species trials, fertilization substantially increased emergence, establishment, and ground cover. This can be attributed to the starter fertilizer effect reported by Klock.[6/] Two possible explanations for poor success of mixtures are reduced seeding rate of each individual species and competition. Quite possibly seeding rates of acceptable species were not high enough to compensate for lack of ground cover from nonacceptable plant species. Although we have no estimate of the importance of competition in this study, results can be compared with those of Tiedemann and Klock.[7/] In their study, of five species seeded after fire, only two, Latar orchardgrass and Durar hard fescue, provided enough ground cover to be considered successful. Cover of orchardgrass stabilized at 4 to 5 percent between the second and fourth years, and hard fescue cover increased during each of the

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[6/] G. O. Klock. Use of a starter fertilizer for vegetation establishment. (Abstr.) Northwest Sci. 43(1): 38. 1969.

[7/] Arthur R. Tiedemann and Glen O. Klock. Development of vegetation after fire, seeding, and fertilization on the Entiat Experimental Forest. Proceedings, 15th Tall Timbers Fire Ecology Conference., Oct. 16-17, 1974, Portland, Oreg.

4 years of their study. Perennial ryegrass and yellow sweet clover provided less than 0.1-percent cover during the first and second years and had disappeared completely from permanent transects by the third year. Drummond timothy cover declined after the second year.

Reasons for failures of the first nonexperimental fireline seedings are relatively unknown other than the periodic disruption of the seed bed by tractor operation for about 2 years. Orchardgrass and timothy are expected to establish when fertilized in most locations; however, the 6 pounds per acre (6.7 kg/ha) seeding rate would probably be marginal for this operation. Wind drift and air wash from the helicopter could have dispersed seed over a much greater area than was intended. Seeding rates equal to or above those in table 1 are recommended. The seed was applied quite late in the fall which may be too late for successful seed germination in the near alpine region. Subsequent fireline plantings of orchardgrass and timothy by the National Forest with a seed drill have been successful in areas below 6,000 feet (1 830 m). Above 6,000 feet, frost heaving was extreme in the spring of 1973; and many seedlings were lost.

CONCLUSIONS

Results of this study show that firelines with severely disturbed soil can be successfully revegetated by artificial seeding on the east Cascade upper slopes of north central Washington. Latar orchardgrass, Drummond timothy, perennial ryegrass, Manchar smooth brome, and tall fescue proved to be the best adapted species for this purpose. Limited success with mixtures of species, whether perennial or perennial-annual, indicates that the best ground cover will probably be achieved with one or two of the above selected species. A starter fertilizer treatment is imperative. Covering the seed by methods such as with a seed drill or harrowing and using mulches, particularly at higher elevations, can be expected to increase the level of success.

On severely disturbed soils, we highly encourage planting practices that will provide cover with native species. In many cases, native species do not spread quickly enough for needed soil surface protection or seed is not available in large quantities. Therefore, a need does exist for the use of "introduced" species.

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